TECHNISCHE UNIVERSITÄT DRESDEN

INSTITUT FÜR BAUINFORMATIK

PROF. RAIMAR J. SCHERER

JAHRESAUSBLICK

RESEARCH AND LECTURE ACTIVITIES IN 2008

December 2007

Research at the ”Institute of Construction Informatics – Bauinformatik” (CiB) is in two directions:

Applied Informatics and ***Applied Stochastics***

The view of the brochure is directed to the future, i.e. to new ideas and what is planned to be done by each research assistant and PhD student in 2008, based on the results achieved in 2007. Current research topics are: (1) building information models, (2) intelligent engineering structures and construction methods, (3) virtual organizations and dynamic process modelling, (4) project risk and simulation management, (5) e-learning. Main basic methods applied are object-oriented methods, grid computing, agent methods, engineering and business ontologies, service-oriented architectures, description logic and information mining.

The institute strongly promotes information technology in research and industry. Prof. Scherer is chairman of the European Association of Product and Process Modelling, which organizes its 7th ECPPM conference hosted by CSTB at Nice, France in early September 2008. In 2006, the conference brought together leading European academic and industrial researchers and developers in construction IT and IAI working groups in Valencia (see *http://www.ecppm.org*).

In late September 2008, the institute will host the 20th annual German-speaking conference on construction informatics “Forum Bauinformatik” (see *http://www.forum-bauinformatik.de/*). This conference is dedicated to young researchers and has developed to a lively forum of exchanging ideas among the research staff of German-speaking institutes of construction informatics.

Know-how transfer to the industry has a high priority for the institute to facilitate practical exploitation of developed innovative IT solutions. For the industry CiB is a National Information Point in construction IT. CiB is active in international and national standardization bodies in the domains of IT-related product, process, and document modelling and holds several chair and vice-chairman positions.

In March 2008, the “Dresdner Bauinformatik-Gesprächskreis” (Dresden Construction Informatics Dialogue) is intended to be held. Presentations of preceding ones are available at *http://cib.bau.tu-dresden.de/ddbig*.

E-learning activities have successfully been continued. (1) An innovative interactive distance-learning tool for object-oriented modelling, programming and software engineering has further been developed. The chosen application environment is construction site simulation. (2) The European on-line master course “Information Technology in Construction”, co-ordinated by the University of Maribor, Slovenia, is in its 4th academic year and can be chosen at 6 European universities. At some universities these lectures have also been offered in local master programmes (e.g. UCC Ireland). CiB’s contributions are lectures in “Data Mining”, “Software Engineering” and “Management Information Systems”.

Collaborative research was reinforced through intensive information exchange with external scientists. In 2007, we were glad to host Prof. Attila Dikbas, Prof. Zeynep Sozen and Prof. Heyecan Giritli of the Istanbul Technical University, Turkey.

In 2007, Dr. Barbara Hauptenbuchner as well as Karin Böttcher and Ingrid Gerk left the institute to retire. We wish them a healthy and interesting life in privacy with their families and friends. The IT lab of the department therefore has got a new young leader: Dr. Uwe Reuter who did his PhD on fuzzy time series for structural analysis problems. He will strengthen our numerical and stochastic branch.

Last February, Martin Keller who left the institute for the University College Cork (UCC), Ireland successfully defended his PhD. In April, Jörg Bretschneider (PhD in December 2006) left the institute for the Frauenhofer Research Institute in Dresden. In July, Matthias Weise (PhD in November 2006) left the institute for an IFC consultancy company and in November, Umut Gökce submitted his PhD thesis.

Three young research assistants have joined our team in May, August and October: Ronny Windisch, Ksenia Rybenko and Faisal Shaukat, resp. Ronny Windisch holds a degree in civil engineering and did his diploma thesis on description logic representation of structural systems, whereas the other two hold degrees in computer science with focus on logic theory and thus will strengthen our knowledge on basic methods in informatics.

Some further information can be found at our web pages http://cib.bau.tu-dresden.de

Dresden, in December 2007 Raimar J. Scherer

Institute of Construction Informatics

		Phone extension	Email name
Head of Institute	Prof. Dr.-Ing. Raimar. J. Scherer	3 35 27	Raimar.J.Scherer
Leading engineer	Dr.-Ing. Peter Katranuschkov	3 22 51	Peter.Katranuschkov
Head IT Lab	Dr.-Ing. Uwe Reuter	3 57 28	Uwe.Reuter
Secretary	Ilona Jantzen	3 29 66	Ilona.Jantzen
Teaching staff	Dipl.-Ing. Ulf Wagner	3 57 41	Ulf.Wagner
	Dipl.-Ing. Gerald Faschingbauer	3 42 62	Gerald.Faschingbauer
Researchers	Dipl.-Ing. Alexander Gehre	3 57 42	Alexander.Gehre
	Dipl.-Ing. Ulf Wagner	3 57 41	Ulf.Wagner
	Dipl.-Ing. Gerald Faschingbauer	3 42 62	Gerald.Faschingbauer
	Dipl.-Ing. Ronny Windisch	3 97 75	Ronny.Windisch
	Dipl.-Ing. Faisal Shaukat	3 57 43	Faisal.Shaukat
	B.Sc. Ksenia Rybenko	3 57 44	Ksenia.Rybenko
PhD students	Jalal Dabagh	3 45 30	Jalal.Dabagh
	Kamil Umut Gökçe	3 57 45	Umut.Goekce
	Wael Sharmak	3 46 15	Wael.Sharmak
	Dipl.-Ing. Karin Eisenblätter	3 59 95	Karin.Eisenblaetter
	MSc. Sven-Eric Schapke	3 36 71	Sven.Schapke
	Amin Zahédi Khaméneh	3 49 57	Amin.Khameneh
	Dipl.-Ing. Steffen Scheler	external	Steffen.Scheler

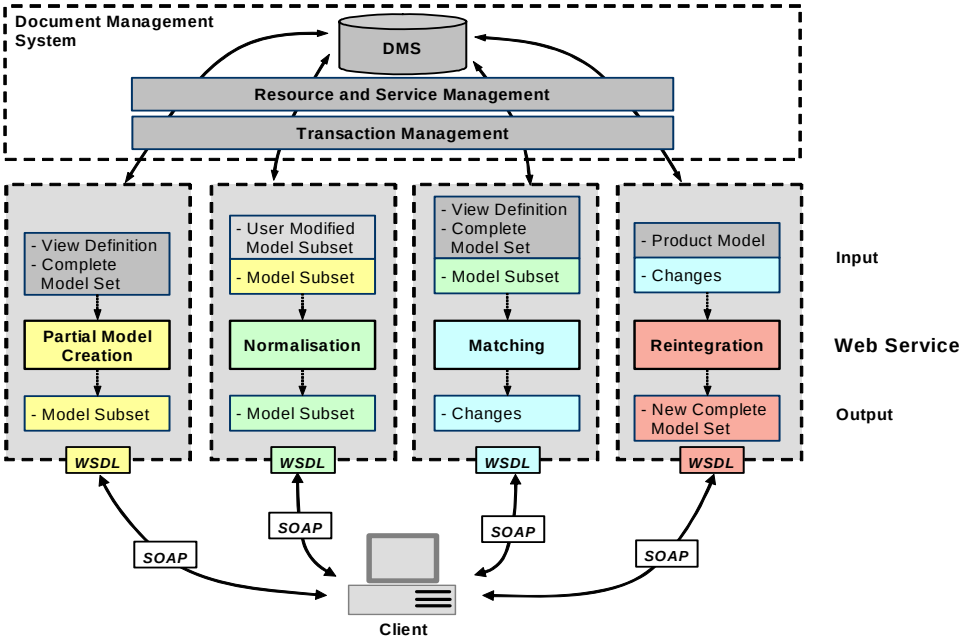
Phone: +49 (351) 4 63-{Phone extension}
Fax: +49 (351) 4 63-3 39 75
Email: {Email name}@cib.bau.tu-dresden.de
{FirstName.FamilyName}@tu-dresden.de
WWW: http://cib.bau.tu-dresden.de
Regular Mail: Technische Universität Dresden, Institut für Bauinformatik, 01062 Dresden
Packages: Technische Universität Dresden, Helmholtzstraße 10, 01069 Dresden
Visitors: Technische Universität Dresden, Nürnberger Str. 31a, 01187 Dresden

Service-Oriented Distributed Product Data Management Functionality

Ronny Windisch, Peter Katranuschkov

Objectives

Providing product model technology to industry means the integration of a product model server into a web-based project environment, thereby leading to a complementary information management system to the current widely-used web-based document management systems. Based on a generalised cooperation scenario it is required to provide adequate product data management functionality to the integrated product model server in order to realize reliable support for delta-based version management, domain/user specific model views and parallel long transactions. Considering the benefits of the Service-Oriented Architecture (SOA) paradigm it is our goal to develop reusable, autonomous product data management services that can be applied in a web-based IT environment to provide the required functionality. In accordance to the cooperation scenario we focus on the following product data management functions: (1) model subset creation (depending on the domain/user specific model view) to be used in a specific work task, (2) normalisation of the changed model subset to avoid data-structural inconsistencies between the input and the output model subset after user modification, (3) comparison of the input and output model subsets to detect the changes resulting by the user modification, and (4) reintegration of the changes to create a new complete data set.



Enhancing a document management system by means of a product model server with web services providing the product data management functionality and their integration into a web-based project environment

Approach

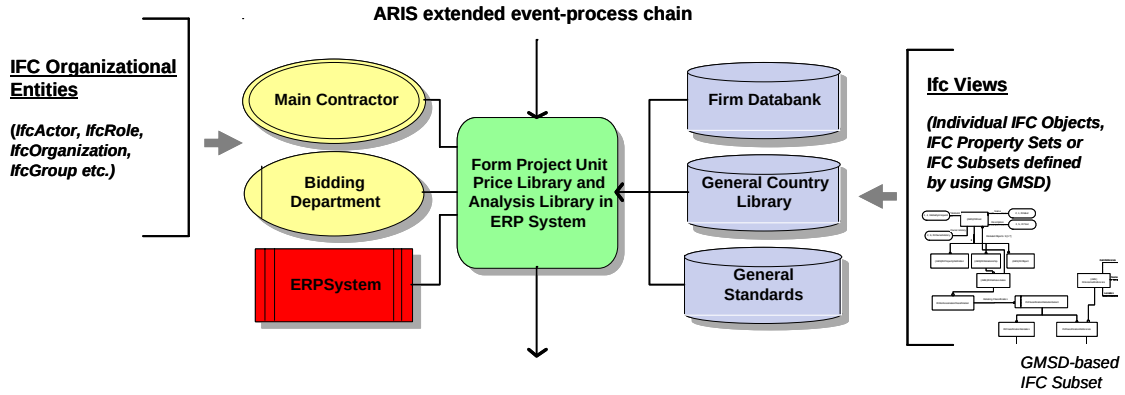
The ordered application of the outlined functions represents the stereotypical business process encompassing not only the specific work tasks including their pre- and post-conditions but also the involved resources and services including their assignment to specific user roles. We use the SOA technology to integrate this business process into a web-based project environment because of its support for decomposing and re-combining small functional units to complete business processes. The product data functionality provided by autonomous web services is well defined and can be described by the expected input and the generated output information according to the executable methods. This is done by means of the XML-based Web Service Description Language (WSDL) specifying the allowed request messages to the web services and the belonging response messages. The communication between the client and the web services is based on the Simple Object Access Protocol (SOAP), which uses XML for data representation and HTTP for transport. Through the developed approach, end users can manage their product model data while retaining all familiar document management functions supported by a project portal, and portal providers can extend their offered services without re-engineering of their portal software.

Information on Integration Based on Process- oriented IFC Sub-Models

K. Umut Gökçe

Objectives

Today, due to the increased interactions and interrelations among the actors and organizations participating in a construction project, there is a well understood need for computer-supported conceptual models that can define precisely the complex communications between all stakeholders so that more efficient concurrent development of the construction facilities can be reached. Although important implementations have been achieved in the last years, the effects on the practical side have not yet reached to expected level. Information is produced in an effective way, but the information management is still the same as is in the past decades. This can be explained by lack of generality in terms of data and process interoperability and the insufficiency of applications utilizing each other's data directly in digital format. This significantly decreases flexibility, information exchange between the component systems and last but not least, inter-enterprise cooperation and knowledge transfer. In spite of it is potential the upcoming common project model IFC of the IAI is practically not used for construction management purposes. In this context, to maintain an integrated generic structure to enable interoperable use of IFC Data, two objectives are possessed (1) establish a common integration model based on the data schemas of the IFC standard, thereby the integration of product, process, cost and management data is supported, (2) provide interoperability methods to integrate legacy systems.



Schematic presentation of the association of IFC data to the CPM Model

Approach

The IFC Object Model is essentially a project data model addressing the major data exchange requirements in the highly diversified AEC environment. However, it comprises a huge amount of information that for individual end-user applications always only a sub-model of the total IFC model is implemented. In order to support practical data exchanges, applications need to develop the same or (at least overlapping) IFC subsets in order to obtain meaningful product data exchange. Such subsets are named as IFC Views. In this context, to provide IFC Views which represent interoperable use of IFC data in a generic Construction Project Management (CPM) Model, the following procedure will be applied. (1) The integrated IT Management Processes defined in extended event-driven process chain (eEPC) model of ARIS will be examined with regard to IFC Views that can or should be related to them. An example for such a view is the IFC View for Product Catalogs. (2)For each identified view the relevant IFC objects and their relevant relationships will be determined. They are then associated to the relevant organizational entities, and the relevant resource entities in the ARIS-eEPC model. In the first case these will always be instances of IFC object classes, but in the second case these can be individual objects, property sets or whole model subsets. (3) Whenever model subsets need to be applied, the IFC Concepts and IFC Instance Diagrams will be defined based on the IFC View Definition Format. (4) In order to bring IFC Concepts together, General Model Subset Definition Schema (GMSD) developed at the TU Dresden will be used for the formal specification of the subset content on class level. This provides dynamic run-time filtering and a dedicated service performing the actual view extraction for the specifically referenced design, resource planning and scheduling domains. (5) Runtime use of the IFC data will be then possessed via a specialized GMSD client which enables proper extraction of the specifically needed IFC instances in each particular situation.

Ontology-based, Agent Supported Information Management for Cross-organisational Project Teams

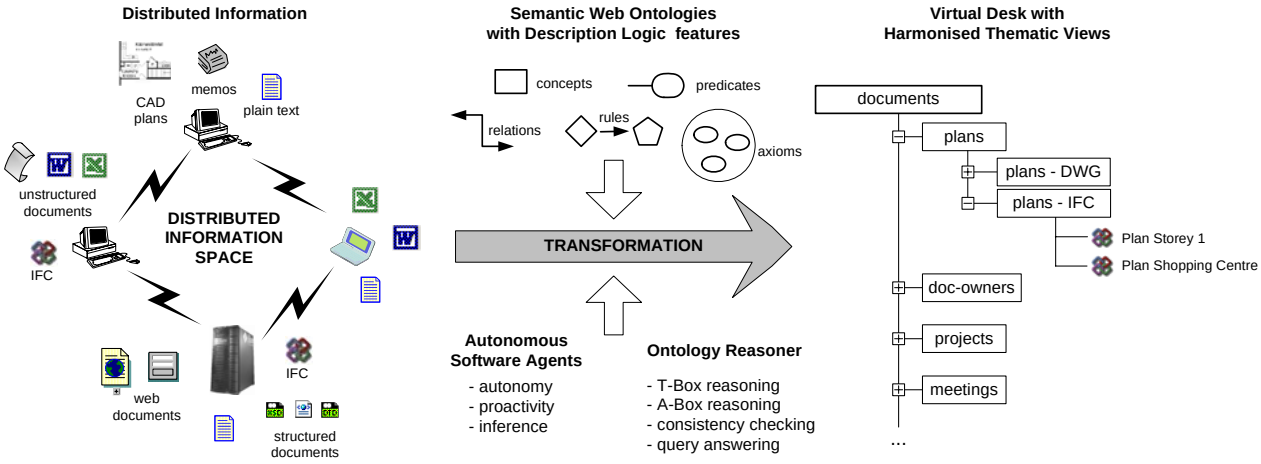
Alexander Gehre

Objectives

Many platform solutions exist to support project teams in document management and collaboration, most of them relying on browser-based client-server applications. However, most of these project platforms are not suitable for small multi-organisational project teams as they cause significant costs and efforts for setup and administration. A more advanced solution should lower the entry barriers and improve the effort-value ratio for small project teams by providing an easy to set up and maintain distributed system together with improved methods for intelligent information management.

Available solutions offer document management features extended by versioning and light-weight metadata functionality, all requiring time-consuming check-in / check-out procedures. The document storage, presented to the users in a folder-based model comparable to a simple taxonomy, does not reflect the implicit knowledge of the users about the different contexts a document may be possibly involved in.

The objective of this research is to develop a system where there is no need to store documents on a central server; they remain on the end user machines. Software agents shall autonomously compile a harmonised ontology-based model of available information. This model can be visualised by interactive thematic views showing relevant information required in a particular context. That kind of ontology-based distributed collaboration will be a distinctive benefit compared to current state-of-the-art web portals for project collaboration.



Ontology-based management of distributed decentralised information resources

Approach

The targeted system for intelligent distributed information management without a centralised storage can be achieved by (1) applying domain ontologies describing documents and the contexts of their usage, (2) an explicit ontology-based Virtual Organisation (VO) model with focus on requirements of small teams and companies, (3) software agent technology used for the automated distributed knowledge-based information management, and (4) a Peer-To-Peer based communication model.

The knowledge-based part of the system is relying on two independent yet interrelated ontologies, a Resource Ontology and a VO Ontology. The Resource Ontology describes in detail general and domain specific information resources, the VO Ontology models organisational aspects relevant for small distributed project teams, as e.g. roles, responsibilities, permissions, VO structure, contact information, etc. Even if both ontologies can be used independently, real surplus value can only be achieved if the information gathered at runtime is merged in a meaningful way, so that implicit, formerly hidden associations are revealed.

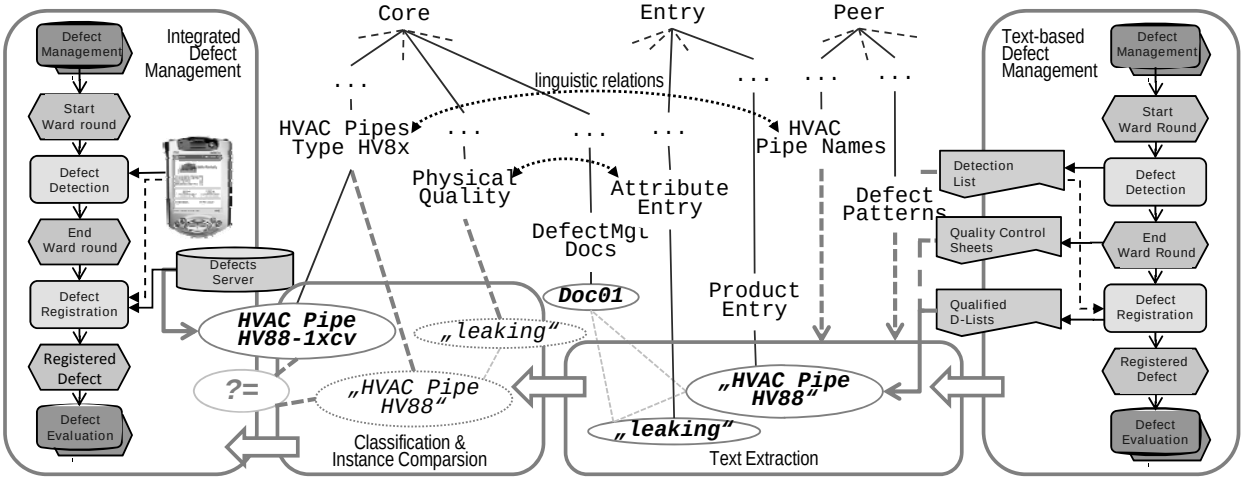
The distributed application itself is built on top of a Multi-Agent framework, which establishes a Peer-To-Peer network in the background. Each node hosts a set of agents that keep track of local information storage allocated to dedicated projects, autonomously collect/create additional ontology-based metadata and context information, and exchange, harmonise and manage that information on global project level.

Ontology-supported Text Extraction and Integration for Monitoring Defect Management Processes

Sven-Eric Schapke

Objectives

The overall aim of this research is to establish text technologies within collaboration environments and utilise general domain knowledge as well as available project context information to support the integration of text information. Two semantic web services, namely the 'Semantic Text Annotation and Extraction Service' (STAN) and the 'Information Resource Sharing and Integration Service' (IRIS) have been introduced to provide for the discovery and the sharing of text content in the context of Semantic Service Environments. This process of text integration is controlled by 'Integration Scenario Definitions' (INSIDE) that specify the required context information, the configuration and orchestration of the text analyses and the routing of discovered information entities. Backbone of the approach is a 'Construction Information Resources Sharing Ontology' (CORSO) that allows for representing the relevant project information in the Core Ontology, the available linguistic knowledge in the Peer Ontology as well as for storing the automatically discovered information of various text resources in the Entry Ontology. Current research focuses on the validation of the overall approach. Case studies will be conducted to get rough estimates of (a) the efforts to specify the INSIDEs and acquire the necessary linguistic resources, (b) the robustness and the performance of the various text extraction and the information integration modules, and (c) the overall applicability and usability of the system in construction practice.



Interrelating Extracted Text Entities (Pipe HV88) with Data Entries (HV88-xcv) in Defect Management

Approach

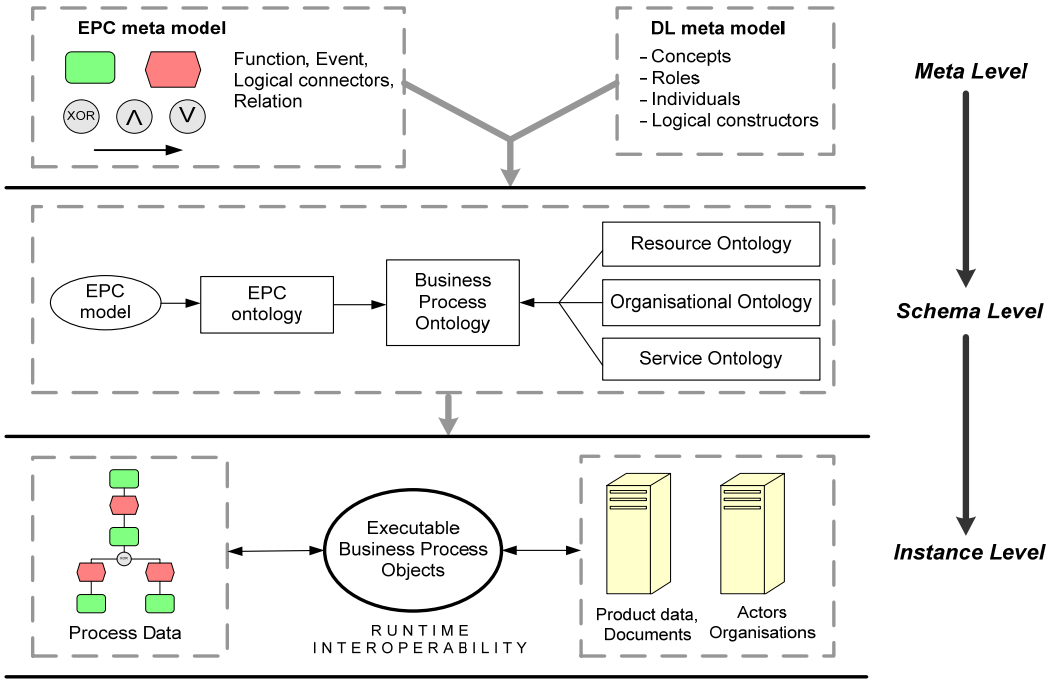
The potentials of integrating text information based on the CORSO Ontology will be examined within the context of defect management. The outline for the test scenario is provided by detailed process models, i.e. a traditional paper-based and an integrated mobile computer-supported defect management process, that have been developed in the research projects ArKoS and BauVOGrid. In addition to the tasks-sequences, the process models specify both the unstructured documents used in the traditional process as well as the electronic messages exchanged by the integrated systems. The case study now acts on the assumption that both structured as well as unstructured defect management information may be exchange in parallel, and text mining and sharing technologies can be used to (re-)integrate the text information. For the testing the STAN and the IRIS Service are configured for handling text information of particular sub-processes and construction trades, such as the clearing of defects on HVAC systems. Firstly, the Core Ontology is extended to represent model-based defect information of the trade. Secondly, corresponding specialty terms and named entity extractors are specified for the Peer Ontology. Thirdly, automatic classifiers and extractors for the correspondent documents of defect management are built. Fourthly, INSIDEs are defined to extract information from the text documents that correspond to the structured defect information to be stored in the Core Ontology. Finally, the consistency checking and automatic classification are tested for discovering inconsistencies among different information resources as well as for triggering respective subtasks and notifications, such as a matching analysis of particular instances.

Description Logic Based Collaborative Process Management

Peter Katranuschkov, Ksenia Rybenko

Objectives

The goal of research is to enable the efficient operability of complex concurrent processes in AEC using highly distributed information resources. Operationally, this can be accomplished through the realisation of Business Process Objects (BPO) that provide generic definitions of business processes together with the related resources, services, events and organisational entities that are used, referenced or involved in these processes. In effect, BPOs should establish reusable component modules that can serve as building blocks for dynamically defined and executed collaborative process chains, thereby combining the advantages of event-driven process chains and description logic based (DL) knowledge representation. A harmonised DL knowledge base encompassing actors, resources and services as well as processes should provide for a collaboration model with clear and unambiguous semantics. On the other hand, modelling of the construction processes can be conveniently done by using EPCs. However, EPCs lack a formal mechanism enabling flow control together with proper resource assignment to processes and explicitly defined actors/roles with respective process-related responsibilities and access rights. DL provides an expedient mechanism for the achievement of interoperability in complex systems with multiple heterogeneous resources but it does not offer inherent methods for the treatment of processes.



Representation levels and their principal interdependencies in the DL knowledge base

Approach

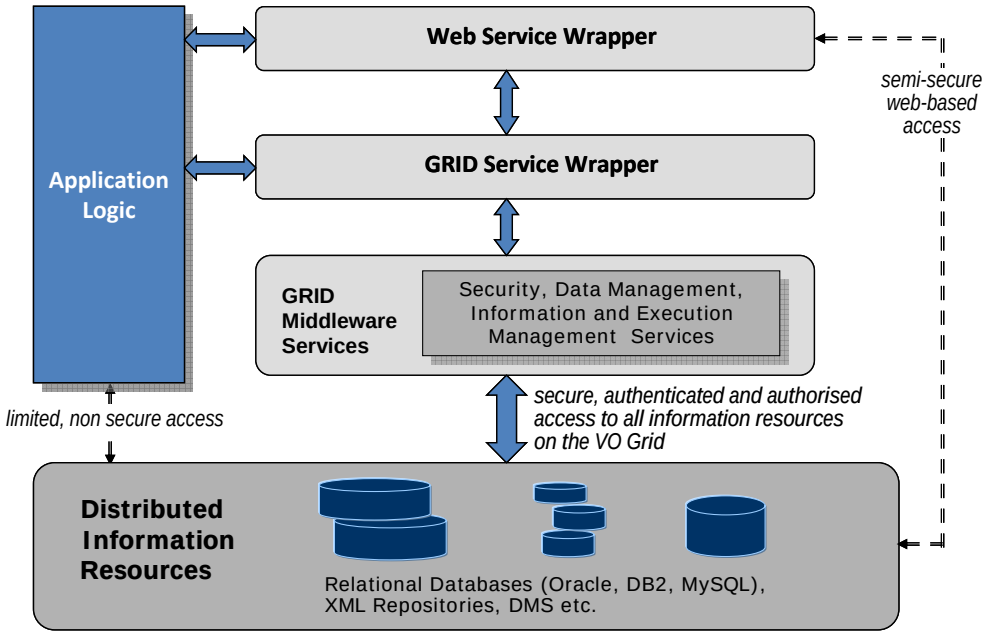
Central issues in the realisation of the DL knowledge base for collaborative process support are (1) the transformation of the EPC model into a DL-based EPC-ontology which is then merged with existing resource, organisational and service ontologies to establish a common *business process ontology*, and (2) the definition and implementation of *configurable BPOs*, as building blocks for dynamic collaborative process chains. Transformation of EPC into DL requires development of mapping mechanisms for the representation of the EPC concepts *function*, *event*, *relation*, and the *logical connectors* AND, OR and XOR into DL. Specifically, AND can be mapped to intersection, OR to union, and (a XOR b) to $(a \cap \neg b) \cup (\neg a \cap b)$ in DL. Flow relations can be represented by using the subsumption relation, together with specially introduced *ordering roles*. In accordance with the logical treatment of actions, every action will have its precondition and effect. Hence, *function* is seen as an action, and *event* is subdivided into *before* and *after* event. Both *functions* and *events* are described as complex concepts with associated actor/role, services and resources. These concepts will be used to instantiate executable BPOs that provide the main building blocks in the knowledge base at runtime. In this way, comprehensive process-centred operability will be achieved, enabling more efficient and better controlled collaborative work processes.

Framework for the Deployment of Engineering Applications on a VO Grid

Faisal Raza Shaukat, Peter Katranuschkov

Objectives

Virtual organisations (VO) in construction pose various challenges to information technology such as the virtualisation of computational and information resources, enhanced security and authentication, concurrent processes, complex role-based authorisation and responsibility structures. Such challenges can be met by Grid technology which provides dependable, consistent, secure, pervasive, and inexpensive access to high-end computational capabilities. On the other hand, Web Service technology enables building loosely-coupled distributed applications based on SOA principles. In practice, there is a need to integrate such engineering web services and locally used applications across distributed, heterogeneous VO infrastructures. Both need to be made available on a VO Grid in order to utilize the security features, information services and execution management of the Grid. The objective is to develop a generic framework and methods for efficient integration of local engineering applications onto a VO Grid taking advantage of standard SOAP-based messaging, interoperability, authenticity, authorization, delegation and quality of service (QoS) offered by the Grid.



Integrating an application onto the VO Grid via Grid and Web Service Wrappers

Approach

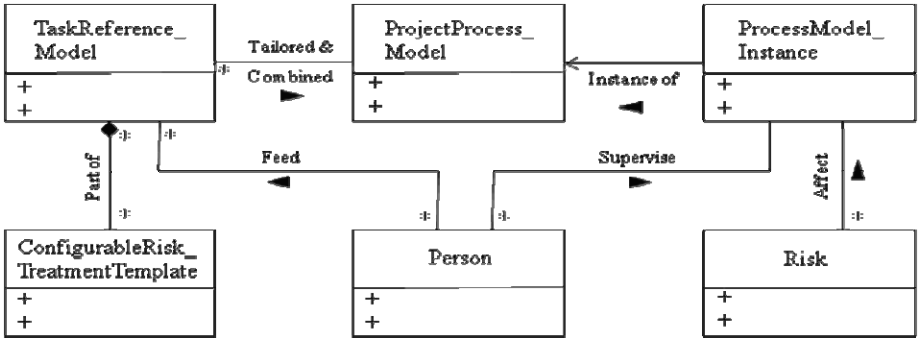
Various strategies need to be investigated for the achievement of a generic solution to the “gridification” problem. The first and most radical strategy is to re-implement the application logic, splitting it into client and grid service. In another approach, the application remains largely untouched and a grid service wrapper is developed around the business logic of the application. In doing so, a standard set of interfaces is exposed by the grid service for interoperating on the VO Grid. These are standard, open and general purpose interfaces as promoted by the Open Grid Services Architecture (OGSA). The grid service wrapper acts essentially as a stateful web service, as opposed to standard stateless web services. Using Java, it is implemented in six distinct steps, namely by (1) defining the service interface in WSDL, (2) implementing the actual service in Java, (3) configuring and deploying the service in WSDD and JNDI, (4) creating a JAR file in Ant, (5) deploying the service into a web service container, and finally (6) configuring the security, data management, information and execution management services of the Grid. However, there exists also a third, even more flexible approach. Its essence is to first provide a stateless web service wrapper for the application logic which is then itself wrapped by a grid service wrapper utilising the steps described above. Whilst this is the most complicated development approach, its advantages are that both grid and web service technologies can be used simultaneously and that the grid service wrapper enables a highly generic realisation, largely hiding grid technology details from the application logic.

Generic Process Template Approach to Support Risk Treatment in Construction

Wael Sharmak

Objectives

No project ever goes totally as planned, as there are many factors which may impact the designed plan and cause changes in the project. However, these factors can be considered as risks which are impossible to be identified completely in advance, as some risks often arise as a result of completely unpredictable events, e.g. human errors. Such risks may occur suddenly and cause problems after a decision has been made or after project execution is started. Therefore, there is a need to react effectively and efficiently to these risks using appropriate reactive treatment procedures. Risk treatment is the concrete change action, among the other risk management subprocesses, which may for example add new tasks to the project plan, cancel, or substitute other tasks. Risk treatment is considered consisting of two parts, proactive and reactive treatment, which can cause even dynamic changes in the project. According to all of this, the main interest in this work is to describe risk treatment process which may affect the project plan and the possible effect scenarios. This is aimed to be done with the help of process modeling techniques by developing a method which supports the creation of adaptable process models. Such models are aimed to represent the project plan with the associated risks for each task, as an assembly of several adapted task reference models. This kind of representation will serve as means of knowledge management by providing all risk-related available information as a response to the actual critical situation.



Risk Treatment template role shown in UML class diagram

Approach

The Event-driven Process Chains method (EPC) will be used to model risk treatment scenarios for two main reasons, (1) as its name indicates it is an event-driven method, and therefore a risk can be represented as a deviation event in the process model and the treatment action will be as a response to the risk event. Such kind of representation is not possible in normal deterministic project planning methods. (2) The EPC method supports configurable modeling, which is also needed for risk treatment modeling because risks are exceptional events, and it will be wrong and will not reflect the actual reality of a risk and its countermeasures to be modeled as normal elements. Risk treatment scenarios will be developed then as risk treatment templates using normal and configurable EPC. These templates, as configurable case-based partial models, can be understood as parts of task reference models, which can be tailored according to the project constraints and combined together in a proper sequence fitting the project conditions to form a configurable process model. The configured process model as process model instance will represent the project plan with the additional risk-related elements. A risk treatment template will not show how to treat a risk, because it is only a “task flow” description which can suit many kinds of risks or risky situations. Therefore, a database includes risks and treatment information must be available and linked to task reference models. Consequently a task reference model will show the function flow within this model, including known-risk affection points and their best-known countermeasures, which will be described in partial models and will follow the structure of one or more suitable treatment templates. This risk database is aimed to be designed using *MySQL* as a relational database management system. It will be needed in a later step to transform these risk data into parts of the configurable task reference models, for this reason a method to represent the data tabular form as a graphical form will be sought.

Controlling of Construction Site Simulations with Interactive eEPCs

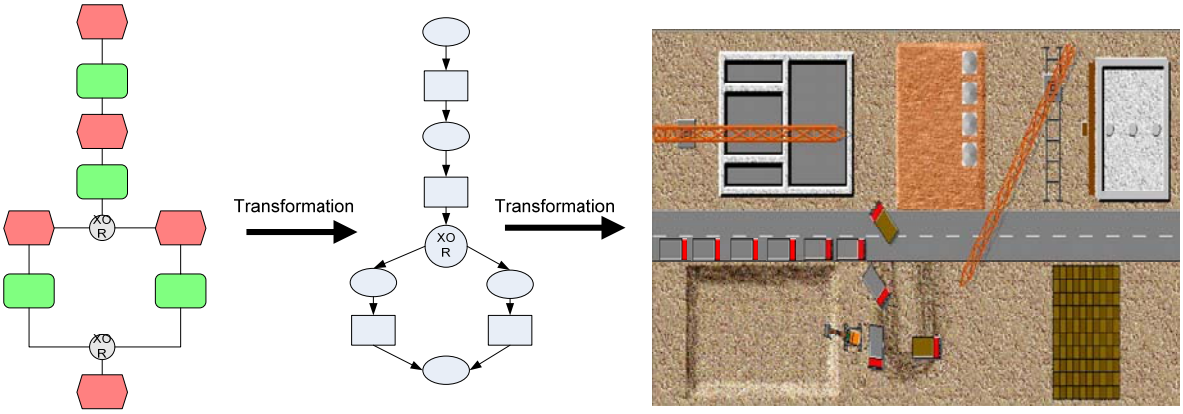
Ulf Wagner

Objectives

Process modelling for constructions sites is an essential need to improve efficiency of labour and to reduce cost. Various tools for project and process management are available at the market. Especially ARIS® become more important in the last years. ARIS® is a tool for horizontal processes modelling based on the method of extended Event-driven Process Chains (eEPCs).

On the other hand are graphical simulation tools, which enable a visualisation of building processes from the construction site. These tools come mostly from mechanical and maritime engineering and are optimised for closed productions sites, like in the automotive industry. Opposed to mechanical engineering, there are permanent changes during the production process at the construction site. This requires permanent revision of input data for the simulation tool.

The objective is to integrate information from various sources and control information management and simulation with eEPC representation on a high process description level. Information is provided from the companies building information system in particular building information systems (BIM) and from information collected through mobile applications and sensors on the construction site.



From eEPCs to Petri nets to detailed construction site simulation

Approach

Whereas eEPCS are excellent for modelling in order to analyse business processes, they are not appropriated for simulation purposes. Simulation tools can better handle Petri nets as input data. Therefore it is intended to transform eEPCs into Petri nets. This transformation has to be formalised, to be done automatically. For the formalisation it is has to kept in mind, that eEPCs and Petri nets have different granularity and some information can get lost or not be available respectively. An eEPCs models the process on a more general level then a simulation for planning, inspecting and controlling a construction process.

Functions of an eEPC have to be more detailed and expanded into a set of construction site activities. Resources described in EPCs as one item can consist of several units. Such eEPC functions have to be available as modules in libraries and to be easy modifiable and configurable by GUIs, using the information system of the company and the project. Also eEPCs models are not standardised and do not show constrains in the decision of the names for the eEPCs events, functions and resources. This makes it impossible to find machine readable information in eEPCs. A set of standard events, functions and resources is needed, which maps the most common one. This set will be organised in a hierarchical object-oriented structure. Therefore analyse of construction site processes will be performed to indentify the commonly used events, functions and resources and to proof the possibility of modularisation and standardisation.

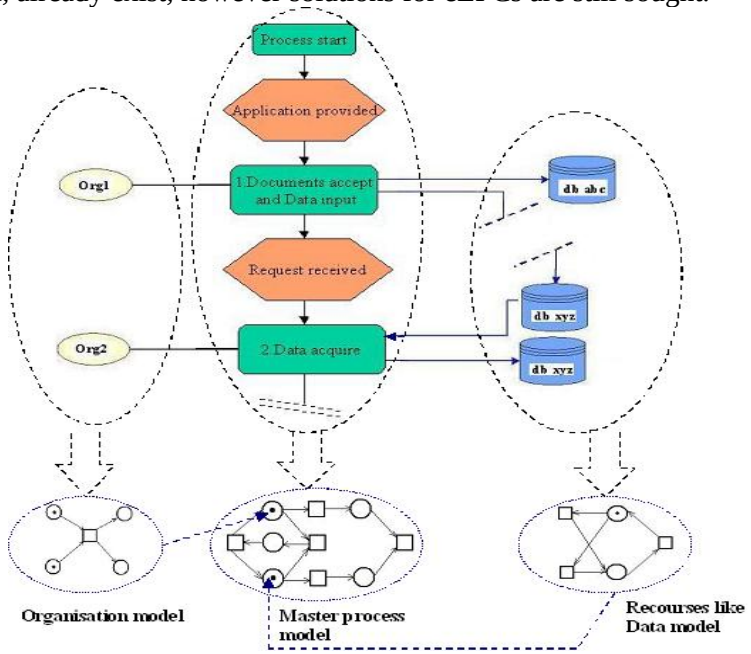
The simulation results will be shown in a simulation platform with a graphical presentation of the construction site providing zoom representation features. The platform will act as a steering tool with a user interaction interface, where the simulation can be online influenced, altered and controlled by user. The interactions can be directly shown at the graphical representation interface and a clear association between user actions and system reactions is visible.

Mapping of eEPC Models into Two-levels Petri Nets to Support Processes Simulation

M. Jalal Dabagh

Objectives

Because of the increasing usage of the process-oriented modelling in constructions, the interest in using these models for simulation to optimize cost, time, and quality is increasing as well. Various modelling tools and methods exist to support the multifaceted usage of process modelling. For example, the eEPCs (Event-driven process chains) is a common and effective tool for process modelling, process analysis, reengineering and design of workflow and information management systems, but not for process simulation. Therefore, models done in eEPCs still need to be mapped to another method like Petri Nets, which enables the computer supported mapping from process modelling to process simulation. A holistic mapping methodology to convert the eEPCs models to Petri Nets models is still missing, which is the main objective of this work. Methods to map simple EPCs to Petri Nets without considering the organizational and data elements, which are main parts of any process model, already exist, however solutions for eEPCs are still sought.



Petri-nets for the organisation units and data units already taken as tokens in the main process model

Approach

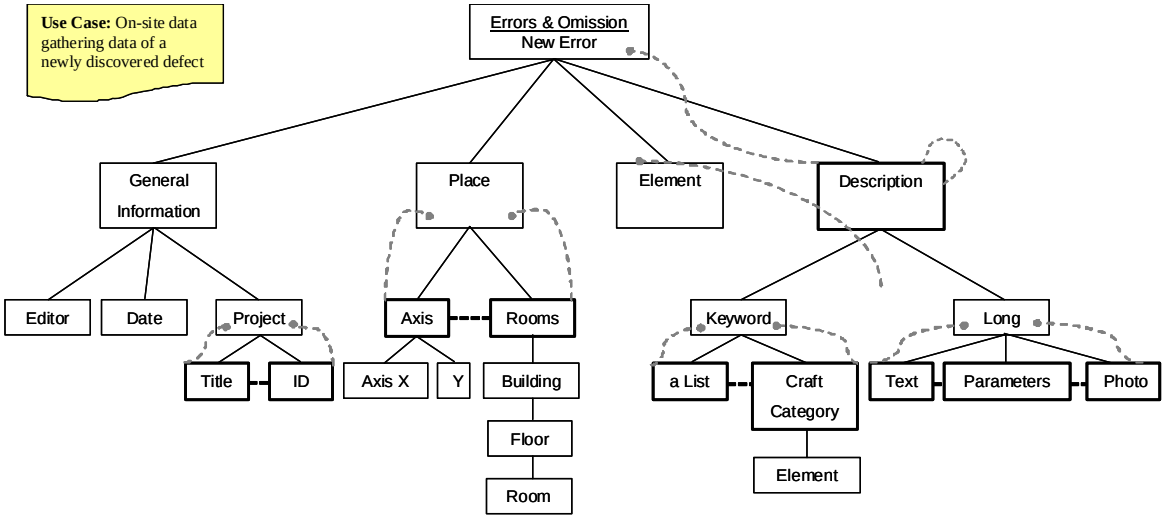
A two-level Petri Net approach is adopted in this work. Organisational units, data units, resource units and other units, which represent the extended parts of EPCs, will be modelled as separate Petri Nets. They constitute the lower level of the two-level approach. Each of these Petri Nets will be then represented as tokens in the master Petri Net, which is obtained from the main EPC. Tokens interrelations between each other and to the master Petri Net will be formulated as well in a later step.
Firstly, the main EPC will be transferred into a master Petri Net without tokens. Then the additional elements will be allocated in groups according to their types, and suitable Petri-net models for these groups will be built, after that these designed models will be added as tokens to the master Petri Net in their suitable places. Tokens in the master Petri Net and tokens in the slave Petri Nets are interrelated, leading to a complex relationship structure between the lower Petri Nets and the upper one. In addition, the case of different used resources which lead to multiple types of tokens will be considered. In this way, a Petri Net model which should fully represent the eEPC model will be obtained. This methodology will be applied to different types of eEPC models in order to check its validity and its ability and to come up with a generic approach. The automation of the whole methodology starting by the insertion of the eEPC models as inputs and ending by the Petri-nets models as outputs of the designed prototype is sought as the general aimed objective of the whole work.

Adaptation Paths for Utilizing User-related and Other Context to Support On-site Data Collection

Karin Eisenblätter

Objectives

Context-adaptivity is one of the key success factors of mobile and ubiquitous computing applications because the applications can adapt itself to different user needs during usage. Such different user needs result from varying actor roles, experiences, qualification profiles, mode of operation etc. Therefore, mobile applications should consider and adapt to context, in such a way, that they are perfectly set for a specific context and allow the user to easily access context-relevant information from anywhere and at anytime.
The research objective is to set up a framework for context-aware mobile applications that support documentation and controlling processes in the AEC sector. Therefore, the framework provides an approach for understanding and formalizing context, for identifying adaptation needs and for implementing context-aware mobile user interfaces and their underlying intelligent services. Currently, a concept is developed to describe electronic data collection forms in a flexible, comprehensive way and to define rules to customize these forms, according to the user's preferred level of detail (determined by the user's context), which leads to more versatile electronic forms that are easier to use than currently used forms.



Containment hierarchy of the individual form elements (represented by the block hierarchy) and the adaptation paths (represented by the dashed lines).

Approach

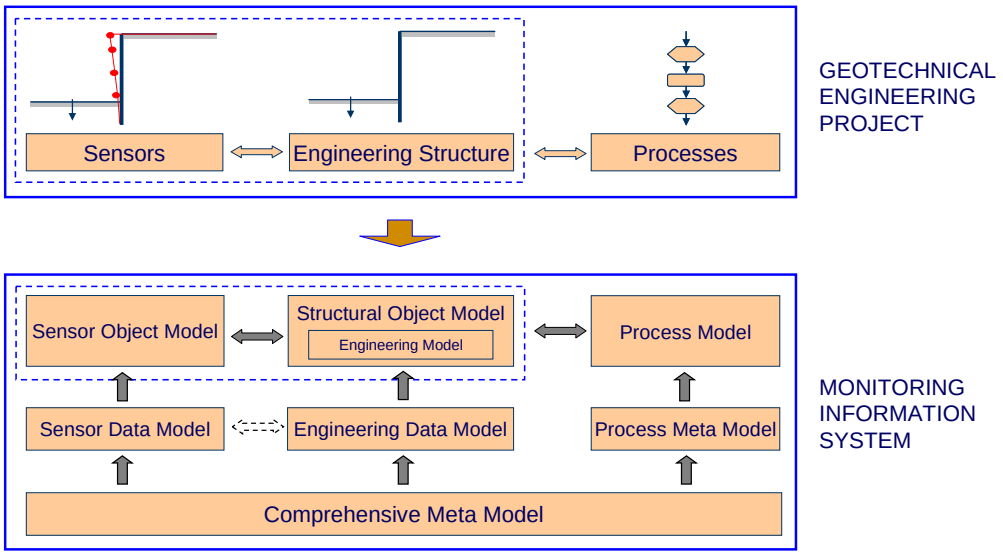
The concept of adaptation path is introduced to bring the envisaged context adaptivity in to mobile site applications. The concept contains three main sub concepts, namely the structure tree, the path and the context connector. The sub concept structure tree comprises a hierarchy with all physical elements of the data collection form. There is a meta-model defining the possible types of nodes within a tree, e. g. singular form element, block of elements and functional elements containing a transformation instruction. A singular form element is a direct representation of a physical form element, where as the functional elements are indirect representations, e. g. by giving a translation instruction that describes how it can be derived from other related elements. While the concept tree structure is a rather static hierarchical collection of the elements themselves, the sub concept path brings the variation into the model. The path is a chain of connected nodes of the tree structure analogue to a link. The nodes can be either selected (only one at a time) or not selected. Each path represents a specific dimension of adaptivity, e. g. the level of detail, the order (work flow) of elements. The selected node within a path will be represented to the user in the data collection form. Adaptations can be user or system initiated and will follow the path either up or down. System-initiated adaptations require the knowledge on which node of the path should be selected and displayed in a particular context. Therefore, there is the concept context connector. Such a connector sets a relationship between a specific context attribute and a particular node within the path. Context connectors can be defined manually by the user or set automatically by a knowledge-base. The concept will be implemented using XML-technologies.

An Information Management System for Monitoring of Geotechnical Engineering Structures

Gerald Faschingbauer

Objectives

Monitoring is more than just the installation of sensors and the comparison of target vs. actual values. Especially during the construction phase, monitoring is embedded in and dependent of the life cycle of the engineering structure. Therefore monitoring must interact with design and construction and consider the various steps of each. Of course, measurements result in each construction phase in different values which have to be interpreted considering their actual context. Engineering models for simulation of structural behaviour have to be adapted according to the measured values and the arising model versions have to be stored and documented in a comprehensible way. The objective of this work is to develop a framework for an information management system that enables the flexible configuration of a monitoring system according to the specific needs of construction projects in geotechnical engineering. This should enable integrating available models, methods and software tools in one monitoring system. An additional focus is the management of sensor data and predicted data which have to be set in the context of both the phases in the construction process and the object model.



Architecture of the Monitoring Information System

Approach

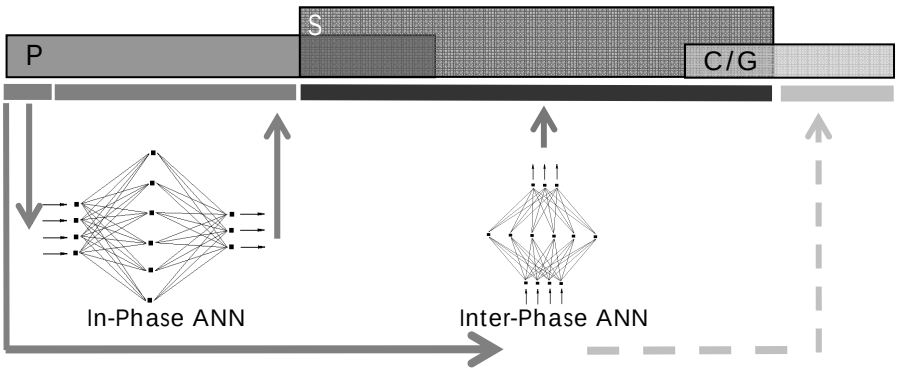
The effective support of observation and interpretation of sensor data by informatic methods with special consideration of the context during the construction process requires an information system which is able to represent the engineering structure itself, the sensors and the corresponding construction and monitoring processes. The relation of the sensor data to the building elements will be realised through object oriented modelling of the sensors as part of the object-oriented structural object model. Therefore a data model for sensors and sensor systems is being developed. The support of the processes and the orchestration of software tools will be based on an integrated process model containing both the monitoring process and the construction process. This process model is comprised of instantiated process patterns for measuring, system identification and updating of engineering models. The process model will be connected to the structural object model and the sensor object model. This will enable relating the monitoring data to their respective construction phase and also to the engineering model representing this construction phase. As already mentioned, during measuring, system identification and model update arise a number of model versions and data related to them. For their proper management and documentation a model management system is needed. A meta model for this model management system will be developed considering especially the requirements on work with engineering models and model composition. It is intended to implement the data models in an object oriented data base and the processes in the Business Process Execution Language BPEL.

Developing a Sequential Seismic Wave Model Based on Artificial Neural Network

Amin Zahédi Khaméneh

Objectives

Most conventional models for generating earthquake ground motion processes are usually referred to as empirical model or prediction model, since the model predicts the empirical relations usually based on a regression analysis. In such models if new characteristic data sets are different from original ones the regression coefficients of the model are modified. In contrast the artificial neural networks (ANN) are more flexible. However, because of the lack of transparency in ANN, the usage of this method must be cautious. Nowadays we know that the seismic time series are dominated by three independent processes (P-, S-, C/G-Waves), which will be the basic sequence (wave phase) of our proposed wave model. According to inter-phase relationships, which are between P- and S-Waves and S- and C/G-Waves, each wave phase can be for most particular application prognosed based on the previous one. According to non-stationarity of the seismic wave even between the individual wave phases the process is not homogenous and a proper model must be designed to perform in- and intra-phase modeling. The sequential seismic wave model should be applied in a real-time seismic wave generator e.g. for active control purposes, which works based on the first received signals of the strong ground motion and is updated continuously during strong ground motion.



The procedure of modelling seismic wave using two artificial neural networks

Approach

To develop a sequential seismic wave model, we apply the Artificial Neural Network (ANN) method as relationship method in two manners, In-phase and Inter-phase. (1) In-phase: based on the records of a time frame the input parameters of the parametric load model will be estimated through an ANN. On this basis the ongoing time series will be generated. (2) Inter-phase: the starting time and the parameters of the S-phase will be forecasted on the basis of the parameters of the previous P- and S-phase, respectively. A feed-forward dynamic ANN with different structures (number of nodes and hidden layers) will be used to detect the more comprehensive form of the network. In addition a replicator Neural Network might be applied to compress the data volume. Two approaches will be performed. In the first approach the ANN will be used to estimate the parameters of the parametric load model developed on the basis of an evolutionary stochastic process model. The parameters are divided into a set of parameters for the spectrum (damping, the resonance frequency and average spectral amplitude ξ, f and S0) and a set of the parameters of the amplitude modulation function. An ANN, trained with a set of classified accelerograms, will be used to generate the parameter of a parametric load model on the basis of the parameters of the already recorded time series. Pre-classifiers like the distance (near, middle- and far field) will be considered to predict a more significant seismic signal. The different wave phases will be identified and determined applying the method of time dependent stochastic principal axes. In order to verify the method the results will be compared with another approach, where the Fourier spectrum will be used as input to ANN rather than the parametric load model.

Research Contracts

Title:	**BauVOGrid – a Grid-based platform for virtual organisations in construction** *(BauVOGrid – Grid-basierte Plattform für die Virtuelle Organisation im Bauwesen)*
Project Leader:	Dr.-Ing. Peter Katranuschkov
Financial Support:	BMBF (German ministry of education and research)
Person Years:	21.2 (total), 6 (CIB, TU Dresden), Duration: 3 years
Approach:	Main motivation is the fact that in construction practice VOs typically include dozens of subcontractors and are characterised by highly complex partner interrelationships distribution of work and responsibilities are intransparent and error-prone, often leading to considerable time and cost loss. A Grid-based platform is going to be developed that enables (1) the formal computer-interpretable representation of authorisation, access control and responsibility structures, (2) the configuration, instantiation and management of both global VO-processes and local partner-internal activities, as well as ad-hoc changes in the project workflow, and (3) flexible access to all kinds of information services both in the office and mobile, at the construction site. The envisaged infrastructure will be achieved by innovative integration of four cutting-edge information technologies, i.e. (1) Grid, (2) Semantic Web, (3) Process modelling and management based on object-oriented eEPCs, and (4) mobile gird-based information and workflow management. The BauVOGrid project contributes to the improvement of VO structuring and operability through an innovative Grid-based VO environment that builds upon developments within the German D-Grid initiative as well as prior work of several project partners in earlier or running EU projects such as InteliGrid, K-Wf Grid , AKOGRIMO.
Partners:	Fraunhofer-Institut für Rechnerarchitektur und Softwaretechnik (Berlin), Institut für Wirtschaftsinformatik im DFKI (Saarbrücken), IDS Scheer AG (Saarbrücken), conject AG (München), Bilfinger Berger AG (Mannheim), Müller-Altvatter Bauunternehmung GmbH & Co. KG, Niederlassung Dresden, RIB Information Technologies AG (Stuttgart), Bundesverband Bausoftware e.V.

Title:	**Product Data Management Services in Distributed Co-operative Design Environments** *(Produktdatenmanagementdienste in verteilten Umgebungen für das kooperative Planen)*
Project Leader:	Dr.-Ing. Peter Katranuschkov
Financial Support:	DFG (German research foundation), Sche223/36-1
Duration:	2, Duration: 2 years
Approach:	The objective of the project is to develop methods and tools to extend existing document management systems to include full product server functionality. This will be achieved on the basis of the Service Oriented Paradigm (SOA). Generic product data management methods for model mapping, matching, re-integration and versioning, initially developed in an earlier DFG-Project (Sche 223-27/3 within SPP 1103), will be further extended, adapted to practical use cases, implemented as self-contained Web Services and integrated in a distributed environment with a proprietary file-based information management project portal. This will enable the interoperable, use of (1) various existing administrative portal services, such as organisation and user management, document management, notification/messaging etc. and (2) the set of innovative product data management services within a coherent environment, without the need to maintain a separately managed Product Model Server. A specific research focus of the project lies on the development of product data management methods for long engineering transactions without data locks. These methods will be implemented in scalable robust algorithms, adapted to the IFC Project Model and deployed as dedicated Web Services within the overall production

environment.

Partners: conject AG (München), Obermeyer Planen + Beraten (München).

Title: **"Campus-Navigator"** – The guidance system of the TU Dresden

Project Leader: Dr.-Ing. Uwe Reuter

Financial Support: TU Dresden

Duration: Since 2001

Approach: Room-related digital data of buildings belonging to the TU Dresden campus are collected by the administration of the TU Dresden. The Campus-Navigator summarizes these data as an externally working system and provides employees, students and visitors these data in a textual and graphical way on an interactive website. All relevant information stored in university's CAFM-system KOPERNIKUS, using an ORACLE database, can be accessed that way. The software visualizes floor and orientation plans in real time out of this data by transforming them into vector graphics in the SVG format, which finally can be displayed in browsers, for instance via the ADOBE SVG plug-in. Linking and visualizing of the graphical and textual data is based on XML. Via a self-managed ORACLE database especially created HTML pages for disabled persons are integrated. Besides the automatic synchronization with the administration databases the content of the curriculum timetables is also provided. With special attention to disabled or mobility restricted persons a routing system (routing through the campus) based on the A-star-algorithm has been developed, which is supported by a parsing process that augments the existing CAD-data with necessary semantics. Advantage of this system is the collection of information from a diversity of data sources, their transformation, graphical rendering and especially the deployment in existing and established networks and end-user environments.

Title: **Appraisal of Methods and Criteria for Sensitivity Analysis at Non-linear Structural Behaviour**

Project Leader: Dr.-Ing. Uwe Reuter

Financial Support: DYNAmore GmbH

Person Years: Since 11/2007

Approach: Structures are described by structural parameters, e.g. for material behaviour. Structural behaviour under live load is simulated by computational models. Structural responses are thus assigned to structural parameters. Structural parameters are subject to random variations, which can be described by probabilistic models. The property randomness of the structural parameters yields random structural responses. Investigation of the influence of fluctuating structural parameters to structural responses is called sensitivity analysis. A lot of established methods on the basis of linear correlation models and criteria exist for sensitivity analysis of (approximately) linear structural behaviour. If there is a non-linear interrelationship between structural parameters and structural responses these methods are improper. Actual developments for appraisal of sensitivity of non-linear interrelationships are auspicious. Within the framework of this project methods and criteria for sensitivity analysis at non-linear structural behaviour have to be appraised and implemented with the aid of a proper programming language.

Lecture Activities 2008

In the new curriculum, starting with the academic year 2006 on 1 October 2006, the students can now choose construction informatics as a competence feature in their studies. This means that in the 3-semester Diploma course, starting with two preparatory lectures two semesters before, students can chose construction informatics as a second subject. As the main subject, Diploma courses are offered for (1) structural engineering, (2) construction management, (3) urban engineering, infrastructure and transportation engineering, (4) hydraulic and environmental engineering and (5) computational engineering. Studies in the Diploma course are organized in modules of 6 hours a week yielding in 5 credit points. The 3 semesters include a project work in the 3rd semester and the Diploma thesis. Both can be done in construction informatics. As construction informatics has to be a complementary subject a pool of 5 modules is offered to the students in order to allow them complementing their basic studies in an optimal and individual way. One of the 5 modules is mandatory, namely WP3-13 "Construction Informatics – Fundamentals", whereas the other two can be chosen out off the remaining four (WP4-XX). Each of the 4 modules is preferably aligned to one of the Diploma courses, which is indicated by intended audience of the course.

Structogram on construction informatics in the civil engineering curriculum

G7 *obligatory*	1st + 2nd semester
GF9 *obligatory*	5th + 6th semester

Diploma/Master courses, if construction informatics competence is chosen

structural engineering	construction management	urban and infrastructure engineering	hydraulic and environmental engineering	computational engineering	
WP3-13 *obligatory*	**WP3-13** *obligatory*	**WP3-13** *obligatory*	**WP3-13** *obligatory*	**WP3-13** *obligatory*	5th +6th semester
WP4-22 *suggested*	**WP4-33** *suggested*	**WP4-60** *suggested*	**WP4-60** *suggested*	**WP4-69** *suggested*	7th+8th semester
select any	*select any*	*select any*	*select any*	**WP4-70**	7th+8th semester

Module G7: Construction Informatics Fundamentals

Intended Audience: Main courses of civil engineering (1st and 2nd semester)
Duration: 2 semesters
Lectures and Tutorials: Scherer/Wagner

Subjects: This module, comprising two courses, provides basic knowledge about algorithms and data structures as well as their modular implementation in an integrated software system. The relational and the object-oriented modelling and programming approaches and the definition and generation of specific views (such as geometrical, topological and graphical representations) are explained on the basis of real AEC objects. The students obtain the ability to think 'object-oriented' in order to structure complex problems modularly and develop generalised modular solutions using algorithms and data structures adequately, with due consideration of their dual and complementary nature. They acquire the capability to formally specify and perform selective, focused modifications as well as further extensions to existing software systems using available software libraries. The module is configured as an e-learning module with object-oriented e-learning tools.

Module GF9: Information Management and Numerical Mathematics

Intended Audience: Main courses of civil engineering (5th and 6th semester)
Duration: 2 semesters
Lectures and Tutorials: Scherer/Reuter

Subjects: The two courses of this module enable the acquisition of knowledge about the basic methods and procedures from the domains of numerical mathematics and information management that are used for the solution of engineering and economic problems in AEC. The students obtain knowledge about principal solution algorithms for linear equation systems and skills in the handling of matrix methods as well as approximation and interpolation techniques, especially using Spline Methods. They learn the fundamentals of Building Product Models and their object-oriented representation which is especially useful for tackling the complexity and heterogeneity of the information resources in construction, the resulting distributed modular data structuring and the related interoperability methods. Basic techniques for the structuring and the formalisation of complex engineering information are presented that empower the students to handle the complex information used in AEC software in such way that it can be efficiently communicated within cooperative design and project management processes.

Module WP3-13: Construction Informatics – Advanced Fundamentals

Intended Audience: All master courses in civil engineering (selectable obligatory module)
Obligatory module for the master courses in Computational Engineering
Duration: 2 semesters (from 5th semester up)
Lectures and Tutorials: Scherer/Katranuschkov

Subjects: The module comprises courses on the topics 'System Theory and Logic' and 'Graph Theory'. It introduces the fundamental principles of Mathematical Logic and provides an overview of the basic rules of 1st and 2nd Order Predicate Logic thereby enabling the acquisition of basic knowledge in conceptual modelling, logical reasoning and consistency checking of complex systems. The fundamentals of Relational Algebra are presented and on that basis the classification of Graphs (as e.g. simple, bipartite, multi- and hyper-graphs) together with their specific properties are explained. Furthermore, the fundamentals of graph based Network Planning are presented including topics like 'paths in networks', 'path algebra', 'flows in networks' etc. Basic knowledge about Petri Nets is also provided to enable the students to (1) develop, (2) formally describe and (3) check in terms of consistency various functions of static and dynamic systems such as the force flows in structural systems, the transportation flow (logistics) in urban planning and construction project management and the overall information and work flows in construction projects (information logistics). The students acquire relevant system-theoretical knowledge and learn composition and representation methods that will enable them to distinguish between various formalisation possibilities such as state-space-based, event-based or activity-based modelling.

Module WP4-22: Cooperative Design Work and Numerical Methods

Intended Audience: Master programme in structural and computational engineering (selectable obligatory module)
Duration: 2 semesters (from 7th semester up)
Lectures and Tutorials: Scherer/Katranuschkov/Reuter

Subject: This module comprises two courses on the topics 'Numerical Engineering Methods and Visualisation' and Methods for Collaborative Work'. The first course imparts basic knowledge about the numerical algorithms for (1) function approximation, differentiation and integration, (2) the solution of non-linear systems of equations, (3) boundary problems in ordinary differential equations of first and higher order, (4) partial differential equations and (5) eigenvalue problems, as well as knowledge about the stability and decidedness of numerical solutions. It provides also principal knowledge about the visualisation of multidimensional variables thereby generating skills to use graphical methods for the visualisation of engineering values and entities in goal-oriented manner, in

order to correctly determine system behaviour. The second course imparts basic knowledge with regard to (1) distributed information management with long engineering transactions, (2) cooperative work methods, (3) workflow methods and (4) data security. On the basis of this module the mathematical and information technology prerequisites for efficient practicing of networked cooperative design work are acquired.

Module WP4-33: Software Systems

Intended Audience:	Master programme in construction management (selectable oblig. module)
Duration:	2 semesters (from 7th semester up)
Lectures and Tutorials:	Scherer/Katranuschkov

Subjects: The module comprises courses on the topics 'System Development' and 'System Integration'. It imparts capabilities (1) to conceptualise an integrated information system that satisfies the requirements of a construction project, and (2) to use efficiently proprietary software programmes applying as much as possible commonly known, typical tools and standardised data structures. The focus of the acquired knowledge is on practice relevant methods of system development, database design, structuring and application, and the conceptualisation of appropriate interfaces. The knowledge acquired in the area of System Development, includes the preparation and use of requirements analyses, the formalisation of the information process and the information flows, the development of system architectures and of meta data structures, and the definition of programming specifications. The knowledge acquired in the area of System Integration addresses the capabilities to develop the structure of a database using a typical database management system (DBMS), create the database itself using standard software tools, conceptualise appropriate interfaces, and integrate data converter, filter and external web-based services.

Module WP4-69: Simulation and Monitoring of Engineering Systems

Intended Audience:	Master programme in hydraulic and environmental engineering (selectable obligatory module)
Duration:	2 semesters (from 7th semester up)
Lectures and Tutorials:	Scherer/Reuter/Faschingbauer

Subjects: This module comprises courses on the topics 'System Simulation' and 'Data and Information Analysis'. It enables the acquisition of skills for multidisciplinary conceptualisation, control and monitoring of dynamic processes in engineering systems, as well as for their modelling and simulation and the definition of appropriate interfaces for their modularisation. The students acquire the necessary knowledge about numerical and computational methods for the simulation of dynamic systems and about various approaches for the application of distributed computing. Furthermore, they acquires knowledge of the basic methods for data analysis and data reduction as well as Fourier, principal axis and wavelet analysis. The module imparts fundamental knowledge on Information and Data Mining Methods that will enable the students to correctly interpret the behaviour of an engineering system in order to identify damage and complex damage inter-relationships, system malfunctioning and system gaps, and establish appropriate risk management procedures.

Module WP4-70: Model-Based Working

Intended Audience:	Master programme in construction management (selectable oblig. module)
Duration:	2 semesters (from 7th semester up)
Lectures and Tutorials:	Scherer/Katranuschkov

Subject: Through the two courses of this module the students acquire capabilities to structure and formalise complex construction projects in order to handle their information logistics and internal relationships efficiently. This enables them to design an appropriate organisational and processing

structure, determine the respective information management methods and procedures and develop appropriate risk management plans. The module imparts knowledge about (1) contemporary modelling methods, (2) object-oriented data structures and the conceptualisation of meta schemas and hierarchical schemas, and (3) interoperability approaches based on methods for model mapping, matching and merging. In the first course detailed knowledge is provided with regard to methods for formal object-oriented system description, the formation of subsystems and consistency checking, and their realisation on the basis of numerical and logical algorithms. In the second course detailed knowledge is provided about the modelling of project processes and process flows, including the complementary information processes and their formal representation.

Module: Building History (read in English)

Intended Audience: Master programme in rehabilitation engineering (1st semester)
Duration: 1 semester
Lectures and Tutorials: Scherer (co-ordination), Curbach, Haller, Herle, Herz, Pohl

Subjects: This module offers a short outline of essential aspects in building history covering the historical development of building technology from medieval times to present. Furthermore the correspondences between social conditions of living and working, the development of urban and suburban areas, the demands on engineering solutions, the development of engineering science and the institutionalisation of engineering education with its feedback to new solution capabilities are outlined. Each lecture is a self contained unit dealing with a special subject showing the development of technology and engineering on best practice examples.
The lectures are Historical Framework (Scherer), Geotechnical Engineering History (Herle), Timber Building History (Haller), Hydraulic Engineering History (Pohl), Bridge Engineering History (Curbach), Structural Engineering History (Scherer), Dresden Baroque (Herz).

Module: Information Systems (read in English)

Intended Audience: Master programme in rehabilitation engineering (2nd semester)
Duration: 1 semester
Lectures and Tutorials: Scherer/Faschingbauer

Subjects: This module is comprised of three parallel courses: (1) Management Information Systems, (2) Information Mining, and (3) GIS for Infrastructure Systems.
The first course introduces the methods for object-oriented modelling of complex engineering systems. Further course material focuses on communication methods and the formal representation of communication goals which allow the efficient application of automatic evaluation and decision support methods and algorithms. A third part of the course is specifically dedicated to the use of control methods and the development of a methodology for performance measurement.
The second course introduces methods for data analysis and data mining, such as correlation and regression, classification, decision trees and clustering, whose practical application aims at the early detection of damages and faulty system behaviour. In conjunction with that the scope of application and how the methods are complemented are discussed. Part of the course is specifically dedicated to data pre-processing since the efficiency of the methods strongly depends on the modelled data.
The third course provides an introduction into graph theory, by which the partitioning and the formal area-related variables dependencies can be described. The mapping from object-oriented data models to area-related representations and the generation of area boundaries by means of data mining methods are discussed. Different ways of graphical representation for complex, multi-layered information in terms of area magnitude are introduced. The lectures and tutorials provide insight into preferred modelling and data analysis techniques for corresponding graphical representation methods.

Course: Informatics in civil engineering

Intended Audience: 6th semester, students of science of the economy
Lectures and Tutorials: Scherer/Reuter

Subjects: This lecture aims at giving an introduction to the specific problems of software in civil engineering, the special requirement to the hardware, the way of work with the software and the future trends. Especially the area of the functionality of CAD- and CAE software will be discussed. The students get a survey of the software used in civil engineering offices and can acquire knowledge that allows them to judge such software products concerning quality and performance. A further aim is to enable the students to assess the expenditures on installation of new software, training of staff to operate it and carrying out of projects by appropriate software products.

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Positions in Editorial Boards of Journals

Advanced Engineering Informatics	Elsevier Publishers	The Netherlands
Automation in Construction	Elsevier Publishers	The Netherlands
Information Technology in Construction (electronic journal)	KTH Stockholm	Sweden
Construction Innovation	Arnold Journals Publisher	Great Britain

Membership in Standardization Groups

DIN Dok-Bau	Standardization committee for technical product documentation in civil engineering	Chairman
DIN NAM 96.4.1-3	Product data exchange in civil engineering	Vice chairman
ISO 10303/BC	Standard Exchange of Product Data, work group Building Construction	Member
IAI	International Alliance for Inter-operability, German Council (product modelling in AEC/FM)	Co-ordinator of the academic group
IAI/ST-4	ST-4 Structural Model	Vice chairman